

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

COMPARISON OF THE VARIOUS METHODS FOR THE DIRECT CALCULATION OF THE
TRANSMISSION FUNCTIONS OF THE 15-MICRON CO₂ BAND WITH EXPERIMENTAL
DATA

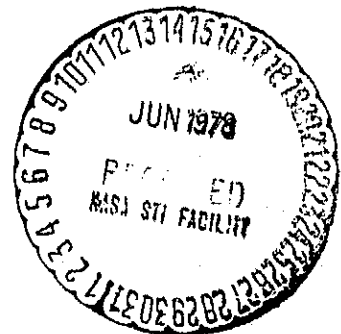
Academy of Sciences, U.S.S.R.

(NASA-TM-75102) COMPARISON OF THE VARIOUS
METHODS FOR THE DIRECT CALCULATION OF THE
TRANSMISSION DIRECT CALCULATION OF THE
TRANSMISSION FUNCTIONS OF THE 15-MICRON CO₂
BAND WITH (National Aeronautics and Space

N78-24400

Unclas
G3/32 21208

Translation of "Sravneniya razlichnykh metodik pryamogo
rascheta funktsiy propuskaniya 15 mkm polosy CO₂ s eks-
perimental'nyimi dannymi", Academy of Sciences USSR, Joint
Soviet-American Working Group on Space Meteorology, Moscow,
March 1978, 39 pp.



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546
MAY 1978

1. Report No. NASA TM 75102		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Comparison of the Various Methods for the Direct Calculation of the Transmission Functions of the 15-micron CO ₂ Band with Experimental Data				5. Report Date May, 1978	
				6. Performing Organization Code	
7. Author(s) Academy of Sciences, U.S.S.R.				8. Performing Organization Report No.	
				10. Work Unit No.	
9. Performing Organization Name and Address SCITRAN Box 5456 Santa Barbara, CA 93108				11. Contract or Grant No. NASW-2791	
				13. Type of Report and Period Covered Translation	
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D.C. 20546				14. Sponsoring Agency Code	
15. Supplementary Notes Translation of "Sravneniya razlichnykh metodik pryamogo rascheta funktsiy propuskaniya 15 mkm polosy CO ₂ s eksperimental'nymi dannymi", Academy of Sciences USSR, 2 Joint Soviet-American Working Group on Space Meteorology, Moscow, March 1978, 339 pp.					
16. Abstract Various methods for calculating the transmission functions of the 15-micron CO ₂ band are described. The results of these methods are compared with laboratory measurements. It is found that program P4 provides the best agreement with experimental results on the average.					
17. Key Words (Selected by Author(s))				18. Distribution Statement Unclassified - Unlimited	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 37	
22.					

COMPARISON OF THE VARIOUS METHODS FOR THE DIRECT CALCULATION OF THE
TRANSMISSION FUNCTIONS OF THE 15-MICRON CO_2 BAND WITH EXPERIMENTAL
DATA

Academy of Sciences, U.S.S.R.

I. INTRODUCTION

/1*

At the present time, the direct method of calculating the transmission function [1], based on numerical frequency integration of monochromatic transmittance, and improved parameters of the thin structure of the absorption bands - which are used as the initial data - is widely used in solving different inverse problems of satellite meteorology. Several publications describe different algorithms for the direct calculation with differing degrees of reliability [1-4]. There are several indeterminacies in selecting the initial information: position, intensity, half-width, and particularly the forms of the absorption line contours and their dependence on physical parameters, different methods of calculating the Voigt function and numerical frequency integration. The problem thus arises of comparing the calculation algorithms, both with reliable experimental data and with each other, in order to develop consistent, accurate, and economical programs for calculating the transmission functions.

In this connection, steps were taken to compare the different calculation methods with the results of recent laboratory measurements of the 15-Micron transmission functions for the CO_2 band by M. O. Bulanina et al [15]. The selection of this band for this comparison was based on very reliable experimental data given in numerical form, and obtained in a wide range of pressures, temperatures, and lengths of the optical beams.

/2

The results are given below of this comparison for four independent programs for calculating the transmission functions:

- 1) Program compiled by V. Deler [17].

* Numbers in margin indicate pagination in foreign text.

- 2) Program compiled by V. M. Osipov [18].
- 3) Program developed at the Leningrad State University.
- 4) Programs developed at the Moscow Physical-Technical Institute [10].

Below, these programs will be designated as P1, P2, P3, and P4. We were faced with the following problems in performing this study:

1. To check the quality of different direct methods of calculating the transmission functions by comparing the calculations with the experimental data.
2. To compare the calculation methods with each other, and also to analyze the possible reasons for the lack of agreement in the results.

2. Initial Spectroscopic Information

At the present time, the following parameters are generally used [11] to characterize the absorption of the separate i -th spectral line;

- position of the line center ν_{oi}
- intensity of the line S_{oi} (for a reference temperature of T_0)
- half-width of the line Δ_{oi} (usually for a unit pressure and reference temperature T_0)
- Forms of the line contour $f(\nu - \nu_{oi})$.

In order to calculate the dependence of the line intensities on ν the temperature T , information is necessary about the energy of the lower level E_i in the form of a pre-exponential factor. For calculations of the half-widths of the lines Δ_i , it is necessary to define the exponent in the relationship $\Delta_i \sim \Delta_{oi} \left(\frac{T_0}{T} \right)^{n_i}$. Finally, for calculations of the emission transformation in various gas mixtures, it is necessary to take into account the effectiveness of collisions of different molecules by means of the expansion effectiveness factors Be (e - index of expanding gas).

In the general case, all of the parameters given above are different for different spectral gases and absorption lines. Since frequently the information about these parameters is far from adequate, different assumptions were used in the calculation methods used (P1, P2, P3, and P4).

Table 1 gives information about the sources of spectroscopic

information used in these programs, the position of the line centers, their intensities, and energies of the lower state, and half-widths of the lines.

Table 1: SPECTROSCOPIC INFORMATION USED IN P1. P2. P3. and P4.

Program (method)	P1	P2	P3	P4
Information about line centers, intensities, and lower-state energy.	Relations from [13]	Calculated according to methods in [9, 12]	Relations from [11]	Relations from [13]
Half widths of lines	Constant $\alpha_0 = 0.07$ $\text{cm}^{-1} \text{atm}^{-1}$	Variable calculated from empirical formula in [14]	Variable relation from [11]	Constant $\alpha_0 = 0.064$ $\text{cm}^{-1} \text{atm}^{-1}$
Exponent n	0.5	0.1	0.5	0.5

/4

3. Brief Description of Programs

Following are the basic parameters influencing the accuracy and rate of calculations:

- number of spectral absorption lines considered;
- form of spectral line used and method of calculating absorption coefficient;
- method of numerical frequency integration!;
- degree of utilization of data from preliminary calculations, different approximations, etc.

The programs P1, P3, and P4 used the Voigt contour for the absorption coefficient

$$K_i(\omega) = K_i^0(\omega) \cdot H(a, \omega)$$

$$a = \frac{\Delta \nu_i}{\Delta \nu_i} \sqrt{\ln 2} \quad \omega = \frac{\nu - \nu_{0i}}{\Delta \nu_i} \sqrt{\ln 2}$$

where $K_i(\omega)$ is the monochromatic coefficient of the i-th spectral

line, Δ_L and Δ_D Lorentz and Doppler half-widths; $H(a, \omega)$ Voigt function. The P2 program uses the Lorentz expression for the absorption coefficient.

A large number of different methods are presently used for calculating the Voigt function. P1 and P4 use the analytical expression obtained by V.S. Matveyev [15], and P3 uses the piece-wise approximation using different expressions in different parts of the region in which the parameters a and ω change. As compared with the methods in [15], this greatly accelerates the calculation process for many of the values of a and ω . It is well-known that if the expression for the frequencies close to the center of the Lorentz line (or the Voigt line) approximates quite accurately the real absorption contour, then /5 its accuracy is poor in the wings of the lines. In this connection, these programs use different empirical methods for calculating absorption in the wings of the lines: P2 and P4 use a modified Benedict contour [16], and P1 and P3 use $K = 0$ at $(\nu - \nu_0) > d$, where d is an empirical parameter ($d = 10 \text{ cm}^{-1}$) and $d = 15 \text{ cm}^{-1}$ for P1 and P3, respectively).

In programs P1 and P4, frequency integration is accomplished with a constant step h , whose value depends on the pressure (for example, the integration step at $p = 1 \text{ atm.}$ is 0.05 cm^{-1} in P1, and 0.02 cm^{-1} in P4. Integration is performed in P2 by the Simpson method with automatic selection of the step and a relative accuracy of 10^{-3} . Integration is performed in P3 over the intervals between the pairs of adjacent spectral lines. Sections of a rapid change in the monochromatic transmission can be distinguished in these intervals, and integration is performed by different methods in these sections and in the remaining sections of the spectral range. It must be noted that such an approach requires additional calculations for analyzing the behavior of the integrand.

To decrease the number of calculations, the total contribution of the far lines is first calculated in P4 for each spectral band, and the weak lines located in this band are calculated for P3. Using a constant integration step, the authors of P4 tabulated the Voigt function for given values of p , T , and h , greatly reducing the number of calculations.

Table 2 summarizes the basic data characterizing the characteristics of these programs. The amount of initial information used is given,

Table 2: BASIC CHARACTERISTICS OF THE PROGRAMS FOR CALCULATING P1, P2, P3, and P4

Method characteristics	P1	P2	P3	P4
I. Initial data				
a) S_{oi} , v_{oi} , E_i	Drayson [13] ₁	Eigen calculations, empirical formula [14]	McClatchey et al [11] Theoretical calculations	Drayson [13] $\alpha_0 = 0.064 \text{ cm}^{-1}$
b) α_{oi}	$\alpha_0 = 0.07 \text{ cm}^{-1}$			
II. Contour used and methods to calculate it.	Foigt, Matveyev formula [15]	Lorentz expression	Foigt, various approximations for different α and ω	Foigt, Matveyev formula tabulated
3. Calculation of line wings	$K_v = 0$ at $ v - v_{oi} > d$	Benedict contour	$K_v = 0$ at $ v - v_{oi} > d$	Benedict contour
4. Frequency integration	Fixed step, depending on pressure	According to Simpson with automatic step selection	With allowance for integrand	Fixed step, depending on pressure
5. Total mass of initial spectroscopic information (in lines)	4000	2000	1000	4000
6. Estimate of computation time (with respect to P3)	10	1.5-2.0	1	less than 1

as well as a comparative estimate of the computational time.

/7

4. Calculation Conditions

A comparison of the calculation results using the programs described above was carried out for 14 specially-selected experimental conditions [5], whose characteristics are given in Table 3. The numerical values of the measured transmission functions for these 14 conditions are given in Appendix 1. The spectral behavior of the half-widths of the equipment spread function a/cm^{-1} is described by the following formulas:

$$\begin{aligned} a &= 0.01074 & \nu &= 3.28; & 580 &\leq \nu \leq 634 \text{ cm}^{-1} \\ a &= 0.008041 & \nu &= 2.69; & 640 &\leq \nu \leq 770 \text{ cm}^{-1} \end{aligned}$$

Table 4 gives the mean square errors for different measurement conditions and different spectral ranges for the characteristics of the transmittance measurement accuracy. The errors in the spectral tie-in of the data do not exceed 1 cm^{-1} .

5. Results of Comparing Experimental Data and Calculation Results

The following numerical characteristics were obtained for analyzing the agreement between the calculated and experimental transmission spectra:

$$\begin{aligned} \Delta(j) &= \frac{1}{N} \sum_{i=1}^N [P_e^j(\nu_i) - P_p^j(\nu_i)] \\ \sigma(j) &= \sqrt{\frac{1}{N} \sum_{i=1}^N [P_e^j(\nu_i) - P_p^j(\nu_i)]^2} \\ \Delta(\nu_i) &= \frac{1}{M} \sum_{j=1}^M [P_e^j(\nu_i) - P_p^j(\nu_i)] \\ \sigma(\nu_i) &= \sqrt{\frac{1}{M} \sum_{j=1}^M [P_e^j(\nu_i) - P_p^j(\nu_i)]^2} \end{aligned}$$

ORIGINAL PAGE IS
OF POOR QUALITY

where j is the number of the comparison conditions (Table 3), N is the frequency number ν_i ; M - number of comparison conditions used in the comparison; P_e^j / ν_i and P_p^j / ν_i - experimental and calculated transmission functions, respectively. The values of Δ / j

and σ / j / are given in Table 5, and Δ / ν_i / and σ / ν_i / are given in Figure 3. Figure 4 illustrates the relationship

$$\delta_K(\nu) = \frac{1}{M} \sum_{j=1}^M [P_{P,K}^j(\nu) - P_{P,P3}^j(\nu)]$$

where K = P1, P2, P4, which provide a determination of the different calculation methods. P3 was selected as the reference program. An analysis of Table 5 and Figures 1-4 points to the following basic conclusions:

1. The agreement between the calculated transmission functions obtained by means of the P1 and P3 algorithms in terms of the average Δ / j / is almost identical ($\Delta (j) \approx 2\%$). The algorithms of P2 and P4 give much better agreement in terms of the average Δ / j /.

2. In the majority of cases, the divergence between P1 and P3, and also between P2 and P4 in certain spectral regions, may be explained by a difference in the initial information. Thus, for example, in the region 645-650 cm^{-1} , the transmission values obtained by using P4 for different experimental conditions exceed the same values obtained using the P2 program by 2-6%, which is apparently explained by the fact that the transition / OIIIOI-0000I / for the $^{16}\text{O}^{13}\text{O}^{16}\text{O}$ isotope with a central frequency of 648.48 cm^{-1} was not taken into account in P4.

3. Program P4 makes it possible to obtain the best agreement with experiment, on the average.

4. The characteristic break in the graphs in the 667 and 681 cm^{-1} regions points to an error in the frequency tie-in of the experiment. The simplest interpolation of the experimental data

$$P'(\nu) = P(\nu_i) + \frac{[P(\nu_{i+1}) - P(\nu_i)]}{\nu_{i+1} - \nu_i} x$$

improves the characteristics Δ / j / and σ / j / by a factor of 1.5 - 2, and decreases the breaks in the graphs (see Figures 3 and 4). Table 6 gives the characteristics Δ / j / and σ / j /

after spectral correction of the data.

5. Thus, P4 is the most accurate and effective. A computational program for the transmission function and for atmospheric nonuniformity was used and successfully applied on the basis of P4. This program makes it possible to carry out calculations for wide spectral regions on an average computer (BESM-4, 28,000 operations per second) in about one hour. The comparatively rapid operation of P4 is achieved by tabulation of the line contour with an accuracy which is sufficient for obtaining results about the transmission with an accuracy of about 1%.

It is planned to carry out similar comparisons for another important CO₂ band centered at 4.3 microns. The experimental transmission functions [5] and the experimental conditions are given in Appendices 3 and 2.

REFERENCES

1. Kondrat'yev, K. Ya., Timofyev, Yu. M.: Direct Methods for calculating transmission functions. Izvestiya AN SSSR, Seriya fiziki atmosfery i okeana, Vol. III, No. 2, 1967.
2. Pokrovskiy, A. G.: Methods for calculating the spectral absorption of infrared radiation in the atmosphere. Problemy fiziki atmosfery, No. 5, Izdatel'stvo LGU, 1967.
3. Scott, N. A.: A direct method of Computation of Transmission functions an inhomogeneous medium. Descriptions of the method. J.Q.R.S.T., 1974, v. 14, pp. 691-704.
4. Drayson, S. R.: Atmospheric Slant Path Transmission in the 15 CO₂ Band. Technical Rep. 05863-6T, The Univ. of Michigan, November, 1964.
5. Bulanim, M. O., et al.: Study of the CO₂ transmission function in the 3.4 and the 15 micron band region. Problemy fiziki atmosfery, No. 13, Izdatel'stvo LGU, 1976.
6. Kondrat'yev, K. Ya., Timofeyev, Yu. M.: Termicheskoye zondirovaniya atmosfery so sputnikov ("Thermal sounding of the atmosphere with satellites). Gidrometeoizdat, Leningrad, 1970.

ORIGINAL PAGE IS
OF POOR QUALITY

7. Timofeyev, Yu. M (editor).: Problema kharakteristik pogloshcheniya v reshenii obratnykh zadach sputnikovoy meteorologii. Otchet sovetskoy rabochey gruppy komissii po radiatsii (Problems of the absorption characteristics in solving the inverse problems of satellite meteorology. Report of the Soviet Working Group of the Radiation Commission) Constance, FRG, May-June, 1973.
8. Timofeyev, Yu. M., Deler, R., Shpenkukh, D.: Comparison of calculated and experimental transmission functions of carbon dioxide in the 15-micron band. Izvestiya AN SSSR, Seriya Fiziki Atmosfery i Okeana, Vol. 8, No. 6, 1977.
9. Osipov, V. M.: Teoreticheskoye issledovaniye IK spektra CO₂ pri vysokikh temperaturakh i davleniyakh (Theoretical study of the Infrared CO₂ spectrum at high temperatures and pressures). Author abstract of dissertation, LGU, 1971.
10. Varnava, V. A., Karasev, A. B., Kondranin, T. V., Krasnyuk, M. V.: Effective method for calculating the transport of infrared radiation in a nonuniform atmosphere. Trudy MFTI, seriya aerofizika i prikladnaya matematika, 1975.
11. McClatchey, R. A., et al.: Atmospheric absorption line parameters compilation. AFCRL-TR-73-0096.
12. Gal'tsev, A. P., Osipov, V. M.: Calculation of the transmission of Infrared Bands of CO₂ at high temperatures and pressures. System of 9.4 - 10.4 micron bands. Izvestiya AN SSSR, Seriya fiziki atmosfery i okeana, Vol 7, No. 8, 1971, page 857.
13. Drayson, S. R.: A listing of wave number and intensities of carbon dioxide absorption lines between 12 and 20 μ m; Technical Report 036350-4-T, University of Michigan, 1973.
14. Winters, B. H., Silverman, S., Benedict, W. S.: Line shape in the wing beyond the band head of 4.3 μ m band of CO₂. J. Quant. Spectr. Rad. Transfer., 4, No. 4, p. 527, 1964.
15. Matveyev, V. S.: Approximate representations of the absorption coefficient and equivalent line widths with Voigt contours. Zhurnal prikladnoy spektroskopii, Vol. 16, No. 2, 1972.
16. Kunde, V., Magnire, W.: Direct Integration transmittance model. J. Quant. Spectr. Rad. Transfer, v. 14, pp. 803-817, 1974.

17. Deler, V., Timofeyev, Yu. M., Shpenkukh, D. O.: Transmission functions of the 15-micron CO_2 band. Problemy fiziki atmosfery, No. 12. 1975. pp. 124-130.
18. Federova, Ye. O., Gasdevich, Ye. S., Kiseleva, M. S., Gal'tsev, A. P., Osipov, V. M.: Characteristics of absorption of infrared radiation of atmospheric carbon dioxide for large optical widths. First All-Union Report on Atmospheric Optics. Tezisy dokladov, Part 1, Tomsk, 1976, pp. 74-77.

Table 3: Calculation Conditions

j	1	2	3	4	5	6	7
Path length L (cm)	497	497	497	497	1470	1470	4874
Pressure P (atm)	0.2006	0.1976	0.1976	0.2006	0.5015	0.5015	1.003
Temperature (K)	293	213	253	313	293	253	293
j	8	8	10	11	12	13	14
Path Length L (cm)	4874	4874	4874	4874	1470	4874	4874
Pressure P (atm)	0.003	0.003	1.003	0.01	0.0502	0.2006	0.0502
Temperature (K)	213	253	313	293	293	293	293

ORIGINAL PAGE IS
OF POOR QUALITY

Table 4: Mean Square Errors of Transmittance P measurements (in percent of absolute transmission).

$\frac{L}{CM} \backslash T_{(K)}$		2I3		253		293		3I3	
497	$\bar{p}$	1.6%	I%	I.4%	I%	I.6%	I%	I.2%	I%
	$\frac{V_1 - V_2}{(CM \cdot T)}$	580-624	624-638	580-589	589-638	580-624	624-648	638-682	580-638
	$\frac{V_1 - V_2}{T}$	638-725	725-770	638-692	692-770	648-725	725-770		682-770
I470	$\bar{p}$	2.4%	2%	I.5%	I.6%	I%	I.6%	I%	I%
	$\frac{V_1 - V_2}{(CM \cdot T)}$	638-675	580-6I9	6I9-638	580-620	620-638	580-620	620-638	638-7I8
	$\frac{V_1 - V_2}{T}$	675-706	706-770	638-7I8	7I8-700	638-7I8	700-638	7I8-770	7I8-770
	$\bar{p}$	2.5%	2%	I.5%	3.5%	2.4%	2.8%	2%	3.5%
	$\frac{V_1 - V_2}{(CM \cdot T)}$	638-694	580-6I4	6I4-638	580-592	592-638	580-596	596-64I	638-696
	$\frac{V_1 - V_2}{T}$	694-7I8	7I8-770	638-694	694-770	64I-699	699-770	580-6I9	6I9-638
								696-733	733-770

ORIGINAL PAGE IS
OF POOR QUALITY

Table 5: Characteristics of σ and Δ

Program	j	I	2	3	4	5	6	7	8	9	10	11	12	13	14	average over all variations
P 1	σ	3.5	3.3	4.9	4.5	3.6	3.5	3.9	3.1	4.4	2.2	3.7	2.4	4.5		3.8
	Δ	+0.7	+0.5	+2.9	+2.0	+2.1	21.9	22.3	+1.5	+2.6	+2.8	+0.5	+0.8	+1.4	+2.4	+1.8
P 2	σ	5.2	4.1	5.3	5.7	3.6	2.6	2.9	3.2	3.5	2.8	X	X	X	X	4.0
	Δ	-1.3	0	+1.6	-0.4	-0.9	-0.3	-0.4	+0.6	+0.7	-0.1	X	X	X	X	0.0
P 3	σ	3.6	3.2	4.7	5.0	3.5	2.9	3.7	2.5	3.5	5.0	4.0	3.3	3.3	4.2	3.9
	Δ	+1.2	0	+2.7	+2.9	+2.2	+1.3	+2.2	0	+1.7	+3.3	+3.0	+1.3	+2.0	+2.4	1.9
P 4	σ	3.5	3.5	4.0	3.9	3.5	3.6	2.2	2.9	3.0	2.5	2.0	2.9	3.6	3.4	3.2
	Δ	-0.8	-0.2	+1.6	+0.3	+0.5	0.1	-0.1	+0.9	+0.7	+0.4	-0.1	-0.1	-1.1	-0.1	0.15

Table 6: Characteristics of σ and Δ after correction of frequency tie-in.

Program \ j		1	2	3	4	5	6	7	8	9	10	11	12	13	14	average over all variations
P1	σ	1.9	1.5	3.1	2.2	2.7	2.6	3.6	2.6	4.1	4.2	1.1	1.7	2.2	2.5	2.7
	Δ	0.4	0.1	2.5	1.7	1.9	1.7	2.1	1.3	2.4	2.6	0.3	0.6	1.4	2.1	1.4
P2	σ	3.4	2.0	2.7	3.0	3.5	2.5	3.0	3.0	3.4	2.9	-	-	-	-	2.7
	Δ	-1.6	-0.3	1.2	-0.7	-1.1	-0.5	-0.5	0.4	0.4	-0.3	-	-	-	-	-0.3
P3	σ	2.0	1.6	3.0	3.2	2.6	2.0	3.5	2.2	3.2	4.5	3.9	1.8	2.5	2.8	2.7
	Δ	0.9	-0.4	2.4	2.6	2.0	1.1	2.0	-0.1	1.5	3.0	2.8	1.1	1.7	2.1	1.5
P4	σ	2.4	2.4	2.6	1.8	2.8	2.9	2.0	2.5	2.6	2.1	1.1	1.3	3.0	2.1	2.3
	Δ	-1.0	-0.4	1.4	0.2	-0.7	-0.1	-0.3	0.7	0.5	0.2	-0.1	-0.1	-1.3	-0.2	0

Appendix 1: Transmission Functions for 15-microns of the CO₂ band.

No spectrum	1	2	3	4	5	6	7	8	9	10	11	12	13	14
path length L (cm)	497	497	497	497	1470	1470	4874	4874	4874	4874	4874	1470	4874	4874
Pressure P (atm)	.2006	.1976	.1976	.2006	.5015	.5015	1.003	1.003	1.003	1.003	.01	.0502	.2006	0.0
Temperature K														
Frequency cm ⁻¹	293	213	253	313	293	253	293	213	253	313	293	293	293	293
600	.996	.998	I	.994	.976	.989	853	I	945	855	996	I	948	996
585	.993	.989	I	.991	.964	.982	765	.899	882	742	.991	I	954	.991
590	.981	.993	I	.988	.926	.916	641	860	795	635	.997	I	912	.997
593	.982	I	I	.976	.890	.982	575	799	678	561	.991	I	886	.991
595	.978	.988	I	.974	.876	.914	508	758	635	495	.986	.993	858	.986
598	.955	.983	I	.955	.782	.859	327	898	459	310	.987	.985	780	.987
601	.975	.990	.998	.967	.845	.872	457	591	508	429	I	.995	650	.995
603	.973	.984	.997	.966	.835	.858	410	563	487	407	.990	.995	636	.990
605	.974	.981	.995	.965	.828	.853	378	530	443	371	.993	.994	800	.993
610	.969	.978	.987	.964	.822	.845	337	490	424	311	I	.992	636	.992
614	.969	.988	.996	.966	.822	.852	317	505	416	297	I	.992	820	.992
615	.966	.987	.990	.962	.767	.834	262	473	371	237	.992	.983	759	.992
616	.894	.956	.943	.886	.654	.726	170	363	268	150	.967	.943	624	.967
617	.797	.822	.884	.786	.472	.572	088	252	157	065	.941	.882	488	.941
618	.743	.855	.804	.729	.412	.492	079	193	130	051	.936	.839	441	.936
619	.797	.879	.835	.776	.539	.578	164	246	196	138	.941	.873	561	.941
620	.899	.929	.931	.885	.697	.744	250	396	319	224	.970	.920	723	.970
621	.955	.976	.979	.954	.788	.858	286	476	375	269	.988	.963	795	.988
622	.964	.990	.980	.961	.799	.845	276	468	365	260	.991	.991	796	.991
625	.958	.977	.965	.954	.680	.745	123	279	188	114	.995	.972	714	.995
630	.893	.940	.937	.880	.493	.565	009	050	030	011	.976	.945	657	.976
634	.851	.899	.879	.811	.375	.484	0	035	007	002	.969	.950	646	.969
640	.783	.814	.802	.776	.242	.256	0	008	004	001	.950	.891	533	.950

643	.751	.762	.776	.759	.205	.192	0	016	010	0	947	871	302	766
645	.729	.711	.743	.728	.184	.138	0	026	0	0	945	867	285	751
647	.649	.677	.715	.679	.134	.116	0	022	018	004	915	844	222	713
649	.568	.514	.555	.523	.055	.043	0	018	002	006	872	717	094	535
650	.569	.503	.532	.549	.039	.024	001	015	004	0	883	738	080	550
652	.619	.571	.634	.643	.066	.037	003	011	002	0	939	817	137	656
657	.594	.503	.584	.620	.046	.017	0	009	0	009	934	818	116	666
660	.621	.518	.613	.651	.051	.023	0	008	013	003	944	833	130	690
661	.628	.536	.619	.666	.055	.033	0	007	009	0	932	828	140	687
662	.615	.516	.613	.656	.056	.029	005	007	004	0	925	798	125	640
663	.601	.511	.591	.650	.044	.034	0	007	0	0	904	798	113	567
664	.637	.545	.638	.665	.052	.030	005	007	008	010	906	808	111	614
665	.688	.581	.678	.727	.063	.029	0	006	0	005	925	853	116	673
666	.662	.546	.652	.719	.056	.025	001	006	0	0	900	836	122	685
667	.478	.389	.472	.541	.029	.015	008	006	009	009	723	665	081	521
667.5	.546	.281	.375	.404	.017	.030	005	006	005	012	625	524	055	395
668	.215	.173	.273	.268	.005	.046	006	006	004	016	525	384	030	270
669	.123	.127	.165	.129	.000	.000	0	006	0	0	513	294	008	145
670	.224	.239	.245	.201	.008	.006	004	005	005	0	658	434	019	231
671	.401	.407	.428	.391	.013	.013	002	005	016	0	813	647	055	437
672	.535	.486	.537	.531	.032	.013	0	005	015	019	834	754	063	564
673	.566	.496	.559	.592	.030	.021	010	004	0	005	902	776	098	604
674	.574	.490	.570	.610	.040	.027	0	004	0	0	915	793	096	644
675	.561	.474	.548	.596	.046	.016	0	004	007	003	921	795	100	639
677.5	.551	.471	.545	.593	.037	.015	0	003	002	005	914	792	114	622
680	.556	.493	.559	.594	.042	.022	0	002	005	005	923	795	119	630
685	.613	.571	.634	.640	.054	.042	0	002	0	004	932	814	147	694
690	.648	.678	.702	.674	.079	.081	007	0	0	0	940	826	160	686
700	.787	.863	.873	.805	.266	.335	001	003	0	001	960	897	385	821
705	.842	.919	.919	.868	.427	.509	012	053	023	0	973	933	517	882
710	.891	.956	.958	.905	.569	.661	044	194	095	030	975	951	642	915
715	.929	.968	.978	.945	.713	.790	179	383	267	143	986	958	757	953
716	.930	.979	.993	.943	.751	.800	191	470	293	170	980	960	761	946
717	.928	.980	.988	.937	.693	.796	167	412	294	142	991	963	719	937
718	.873	.962	.949	.857	.581	.708	122	352	225	101	982	939	606	877
719	.769	.902	.866	.772	.402	.556	065	246	154	045	956	868	434	783
720	.696	.836	.784	.680	.320	.406	053	152	055	034	935	816	557	712
722	.839	.896	.903	.840	.652	.685	264	361	312	212	960	892	671	849

724	.965	.987	I	.988	.870	.904	443	602	545	400	994	978	88I	985
725	.96I	.990	I	.979	.87I	.90I	438	580	533	4I0	987	978	870	985
727	.96I	.979	I	.978	.837	.880	4I8	553	48I	378	I	976	860	982
735	.948	.989	I	.969	.8II	.838	358	476	4I4	348	I	970	846	978
739	.954	.985	I	.969	.798	.852	337	524	44I	296	I	967	830	98I
740	.948	.983	I	.96I	.774	.842	292	535	404	263	998	970	784	959
74I	.948	.990	.999	.955	.746	.832	262	570	385	225	996	960	765	952
750	.98I	.993	I	.985	.9I4	.95I	628	837	7I2	595	996	982	924	999
755	.982	I	I	.994	.944	.932	704	9I9	829	668	995	99I	949	I
760	.987	I	I	I	.963	.99I	837	963	889	780	986	990	966	994
770	.990	I	I	.997	.975	.993	877	975	86I	860	995	99I	967	I

ORIGINAL PAGE IS
OF POOR QUALITY

Appendix 2: Experimental Transmission Functions (4.3 micron band)
 Region: 2200-2425 cm^{-1} , step - 1.0 cm^{-1}

	P (nt)	T ($^{\circ}\text{K}$)	(cm)
I	p=10.03	T=213 $^{\circ}$	=497
2	p=66.66	T=213 $^{\circ}$	=497
3	p=10.003	T=213 $^{\circ}$	=1470
4	p=26.85	T=213 $^{\circ}$	=1470
5	p=66.85	T=213 $^{\circ}$	=1470
6	p=480.2	T=213 $^{\circ}$	=497
7	p=186.4	T=253 $^{\circ}$	=497
8	p=66.86	T=253 $^{\circ}$	=497
9	p=10.330	T=253 $^{\circ}$	=497
10	p=10.030	T=253 $^{\circ}$	=1470
11	p=10.030	T=253 $^{\circ}$	=4874
12	p=26.85	T=253 $^{\circ}$	=4874
13	p=10.03	T=310 $^{\circ}$	=497
14	p=66.86	T=310 $^{\circ}$	=497
15	p=478.1	T=310 $^{\circ}$	=497
16	p=97.25	T=310 $^{\circ}$	=1470
17	p=26.34	T=310 $^{\circ}$	=1470
18	p=186.4	T=310 $^{\circ}$	=1470
19	p=10.03	T=310 $^{\circ}$	=4874

Appendix 3: Experimental Transmission Functions of the Absorption Band at 4.3 Microns.
Initial Frequency - 2200 cm^{-1} , step - 1 cm^{-1}

Fig 1

<u>1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.0, 1.0, 1.000,</u>
<u>1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000</u>
<u>1.000, 1.000, 1.000, 1.000, 0.999, 0.998, 0.997, 0.996, 0.995, 0.993, 0.991, 0.989</u>
<u>0.986, 0.986, 0.983, 0.981, 0.930, 0.977, 0.974, 0.970, 0.968, 0.966, 0.961, 0.96</u>
<u>0.958, 0.953, 0.950, 0.945, 0.942, 0.936, 0.933, 0.928, 0.925, 0.920, 0.918, 0.91</u>
<u>0.911, 0.905, 0.901, 0.896, 0.893, 0.888, 0.885, 0.880, 0.879, 0.878, 0.872, 0.868</u>
<u>0.864, 0.864, 0.861, 0.859, 0.859, 0.860, 0.855, 0.859, 0.862, 0.878, 0.888, 0.893</u>
<u>0.885, 0.866, 0.849, 0.832, 0.824, 0.813, 0.803, 0.792, 0.785, 0.779, 0.768, 0.764</u>
<u>0.762, 0.763, 0.761, 0.754, 0.746, 0.739, 0.731, 0.730, 0.731, 0.727, 0.707, 0.680</u>
<u>0.657, 0.636, 0.621, 0.603, 0.583, 0.564, 0.552, 0.537, 0.529, 0.502, 0.471, 0.426</u>
<u>0.393, 0.363, 0.337, 0.309, 0.288, 0.278, 0.266, 0.247, 0.222, 0.200, 0.184, 0.172</u>
<u>0.157, 0.147, 0.133, 0.121, 0.108, 0.103, 0.103, 0.104, 0.103, 0.100, 0.099, 0.103</u>
<u>0.110, 0.129, 0.158, 0.210, 0.263, 0.289, 0.264, 0.213, 0.165, 0.142, 0.119, 0.096</u>
<u>0.075, 0.065, 0.061, 0.061, 0.062, 0.064, 0.070, 0.079, 0.091, 0.107, 0.127, 0.153</u>
<u>0.185, 0.222, 0.265, 0.315, 0.370, 0.429, 0.491, 0.552, 0.611, 0.668, 0.721, 0.763</u>
<u>0.808, 0.846, 0.879, 0.906, 0.929, 0.947, 0.961, 0.972, 0.979, 0.984, 0.988, 0.991</u>
<u>0.993, 0.994, 0.994, 0.995, 0.995, 0.995, 0.995, 0.995, 0.995, 0.995, 0.995, 0.995</u>
<u>0.995, 0.995, 0.995, 0.995, 0.996, 0.996, 0.996, 0.996, 0.996, 0.997, 0.996, 0.997</u>
<u>0.996, 0.997, 0.995, 0.996, 0.996, 0.996, 0.997, 0.997, 0.997, , -</u>

0.994, 0.994, 0.995, 0.994, 0.995, 0.995, 0.996, 0.995, 0.994, 0.994, 0.993, 0.991,
 0.993, 0.993, 0.994, 0.993, 0.993, 0.994, 0.994, 0.994, 0.993, 0.991, 0.990, 0.991,
 0.992, 0.990, 0.985, 0.979, 0.973, 0.966, 0.959, 0.953, 0.946, 0.936, 0.927, 0.915,
 0.904, 0.893, 0.879, 0.867, 0.856, 0.840, 0.822, 0.804, 0.789, 0.779, 0.774, 0.761,
 0.728, 0.692, 0.660, 0.631, 0.609, 0.585, 0.563, 0.545, 0.535, 0.519, 0.500, 0.472,
 0.453, 0.430, 0.407, 0.384, 0.365, 0.349, 0.338, 0.324, 0.280, 0.280, 0.287, 0.277,
 0.266, 0.260, 0.251, 0.251, 0.252, 0.255, 0.255, 0.271, 0.290, 0.341, 0.396, 0.415,
 0.378, 0.312, 0.262, 0.214, 0.186, 0.165, 0.153, 0.137, 0.117, 0.101, 0.094, 0.095,
 0.091, 0.093, 0.093, 0.084, 0.070, 0.058, 0.056, 0.064, 0.070, 0.062, 0.046, 0.030,
 0.019, 0.011, 0.007, 0.003, 0.001, 0, 0.001, 0.003, 0.002, 0.003, 0.003, 0.003,
 0.003, 0.003, 0.003, 0.004, 0.004, 0.003, 0.003, 0.004, 0.004, 0.005, 0.004, 0.004,
 0.004, 0.003, 0.004, 0.004, 0.004, 0.004, 0.004, 0.004, 0.005, 0.004, 0.003, 0.003,
 0.003, 0.004, 0.003, 0.003, 0.004, 0.002, 0.004, 0.001, 0.003, 0.003, 0.002, 0.003,
 0.003, 0.003, 0.003, 0.001, 0.002, 0.001, 0.001, 0.002, 0.001, 0.001, 0.001, 0.001,
 0.001, 0.002, 0.002, 0.001, 0.000, 0.00, 0.00, 0.001, 0.004, 0.011, 0.028, 0.059,
 0.110, 0.184, 0.275, 0.374, 0.475, 0.571, 0.655, 0.726, 0.783, 0.817, 0.856, 0.885,
 0.906, 0.920, 0.930, 0.936, 0.941, 0.944, 0.947, 0.950, 0.954, 0.956, 0.959, 0.962,
 0.965, 0.967, 0.969, 0.971, 0.973, 0.975, 0.977, 0.980, 0.981, 0.983, 0.984, 0.986,
 0.987, 0.987, 0.983, 0.988, 0.990, 0.990, 0.993, 0.993, 0.995, -

13 21

 ORIGINAL PAGE IS
 OF POOR QUALITY

0.998, 0.997, 0.998, 0.998, 0.998, 0.998, 0.998, 0.996, 0.996, 0.996, 0.995, 0.994,
 0.993, 0.993, 0.998, 0.997, 0.996, 0.995, 0.996, 0.994, 0.995, 0.994, 0.994, 0.993,
 0.993, 0.992, 0.990, 0.987, 0.986, 0.985, 0.982, 0.982, 0.978, 0.976, 0.973, 0.971,
 0.967, 0.962, 0.959, 0.956, 0.954, 0.951, 0.948, 0.945, 0.940, 0.936, 0.933, 0.930,
 0.922, 0.914, 0.904, 0.896, 0.890, 0.885, 0.876, 0.872, 0.867, 0.859, 0.855, 0.848,
 0.839, 0.828, 0.821, 0.811, 0.808, 0.797, 0.798, 0.791, 0.787, 0.783, 0.766, 0.761,
 0.750, 0.759, 0.753, 0.752, 0.755, 0.755, 0.752, 0.751, 0.758, 0.781, 0.808, 0.821,
 0.805, 0.771, 0.742, 0.717, 0.705, 0.688, 0.674, 0.658, 0.644, 0.630, 0.615, 0.606,
 0.603, 0.605, 0.601, 0.590, 0.578, 0.566, 0.557, 0.559, 0.569, 0.559, 0.531, 0.487,
 0.453, 0.423, 0.399, 0.375, 0.357, 0.336, 0.323, 0.302, 0.285, 0.260, 0.231, 0.199,
 0.165, 0.133, 0.116, 0.097, 0.082, 0.072, 0.062, 0.052, 0.041, 0.033, 0.023, 0.023,
 0.020, 0.016, 0.013, 0.010, 0.007, 0.005, 0.005, 0.005, 0.005, 0.005, 0.005, 0.006,
 0.007, 0.010, 0.016, 0.032, 0.051, 0.065, 0.057, 0.040, 0.021, 0.011, 0.005, 0.003,
 0.001, 0.001, 0.001, 0.001, 0, 0, 0.001, 0.001, 0.002, 0.004, 0.007, 0.012, 0.021,
 0.032, 0.049, 0.075, 0.110, 0.156, 0.211, 0.277, 0.350, 0.427, 0.508, 0.584, 0.655,
 0.722, 0.781, 0.821, 0.864, 0.899, 0.927, 0.949, 0.965, 0.977, 0.985, 0.991, 0.995,
 0.997, 0.999, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.000, 1.000, 1.000, 1.000, 1.000,
 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000,
 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000,

4

0.999, 0.999, 0.999, 0.999, 0.998, 0.997, 0.997, 0.997, 0.995, 0.996, 0.996, 0.994,
0.994, 0.993, 0.997, 0.996, 0.995, 0.996, 0.997, 0.997, 0.998, 0.999, 1.0, 0.999,
0.995, 0.992, 0.987, 0.983, 0.978, 0.974, 0.970, 0.966, 0.958, 0.952, 0.946, 0.940,
0.930, 0.922, 0.914, 0.906, 0.899, 0.889, 0.879, 0.866, 0.854, 0.847, 0.844, 0.839,
0.817, 0.791, 0.766, 0.746, 0.729, 0.715, 0.697, 0.684, 0.675, 0.663, 0.651, 0.639,
0.613, 0.594, 0.575, 0.550, 0.539, 0.518, 0.514, 0.501, 0.492, 0.484, 0.468, 0.453,
0.435, 0.441, 0.432, 0.433, 0.429, 0.440, 0.438, 0.437, 0.452, 0.492, 0.544, 0.570,
0.543, 0.484, 0.429, 0.385, 0.358, 0.332, 0.317, 0.296, 0.274, 0.254, 0.241, 0.235,
0.231, 0.233, 0.232, 0.221, 0.201, 0.182, 0.173, 0.162, 0.195, 0.188, 0.159, 0.124,
0.099, 0.080, 0.066, 0.055, 0.047, 0.040, 0.035, 0.026, 0.020, 0.014, 0.010, 0.007,
0.006, 0.005, 0.004, 0.004, 0.003, 0.004, 0.004, 0.004, 0.004, 0.002, 0.001, 0.001,
0, 0, 0.001, 0, 0.001, 0, 0.001, 0.001, 0.001, 0.001, 0.001, 0, 0, 0, 0,
0.001, 0, 0.002, 0.003, 0.002, 0.003, 0.003, 0.002, 0.002, 0.002, 0.002, 0.002, 0.00
0.003, 0.003, 0.003, 0.003, 0.003, 0.002, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001,
0.002, 0.005, 0.012, 0.028, 0.057, 0.104, 0.163, 0.249, 0.345, 0.445, 0.543, 0.634,
0.713, 0.778, 0.816, 0.864, 0.900, 0.927, 0.946, 0.959, 0.968, 0.973, 0.976, 0.976,
0.979, 0.980, 0.980, 0.981, 0.982, 0.983, 0.984, 0.985, 0.987, 0.988, 0.990, 0.991,
0.992, 0.992, 0.994, 0.994, 0.995, 0.995, 0.996, 0.996, 0.997, 0.998, 0.998, 0.999,
0.999, 1.0, 1.0, 1.000, 1.000,

0.994, 0.993, 0.992, 0.992, 0.991, 0.993, 0.993, 0.992, 0.992, 0.989, 0.988, 0.989,
 0.988, 0.987, 0.989, 0.988, 0.987, 0.987, 0.988, 0.987, 0.989, 0.988, 0.991, 0.990,
 0.983, 0.974, 0.963, 0.949, 0.936, 0.923, 0.910, 0.899, 0.886, 0.872, 0.854, 0.837,
 0.818, 0.796, 0.776, 0.756, 0.742, 0.724, 0.696, 0.667, 0.644, 0.635, 0.631, 0.617,
 0.572, 0.520, 0.472, 0.433, 0.401, 0.374, 0.347, 0.328, 0.316, 0.297, 0.271, 0.238,
 0.214, 0.196, 0.182, 0.166, 0.156, 0.139, 0.128, 0.111, 0.097, 0.088, 0.079, 0.071,
 0.072, 0.071, 0.066, 0.064, 0.064, 0.063, 0.067, 0.071, 0.092, 0.120, 0.156, 0.176,
 0.158, 0.122, 0.086, 0.059, 0.040, 0.029, 0.025, 0.021, 0.016, 0.012, 0.010, 0.011,
 0.011, 0.011, 0.011, 0.010, 0.008, 0.006, 0.006, 0.006, 0.007, 0.007, 0.004, 0.003,
 0.003, 0.002, 0.002, 0.002, 0.002, 0.002, 0.003, 0.002, 0.002, 0.002, 0.002, 0.002,
 0.001, 0.002, 0.002, 0.002, 0.002, 0.002, 0.001, 0.002, 0.002, 0.001, 0.002, 0.002,
 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0.002, 0.001, 0.002, 0.002,
 0.002, 0.002, 0.002, 0.002, 0.002, 0.002, 0.001, 0.002, 0.001, 0.001, 0.001, 0.001,
 0.001, 0.001, 0.001, 0.001, 0.001, 0.000, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001,
 0.001, 0.001, 0, 0, 0, 0, 0, 0, 0, 0, 0.001, 0.003, 0.010, 0.029, 0.064, 0.120,
 0.193, 0.281, 0.374, 0.463, 0.544, 0.611, 0.666, 0.710, 0.743, 0.768, 0.788, 0.805,
 0.823, 0.834, 0.844, 0.853, 0.862, 0.870, 0.878, 0.886, 0.893, 0.900, 0.906, 0.912,
 0.918, 0.923, 0.928, 0.932, 0.936, 0.940, 0.943, 0.946, 0.950, 0.953, 0.956, 0.959,
 0.961, 0.964, 0.966, 0.969, 0.971, 0.973,

ORIGINAL PAGE IS
OF POOR QUALITY

6

0.974, 0.971, 0.968, 0.963, 0.962, 0.959, 0.958, 0.954, 0.950, 0.945, 0.941, 0.939,
 0.940, 0.933, 0.937, 0.934, 0.935, 0.937, 0.938, 0.939, 0.939, 0.938, 0.935, 0.928,
 0.910, 0.882, 0.847, 0.809, 0.766, 0.728, 0.688, 0.652, 0.614, 0.572, 0.529, 0.482, 0.445,
 0.373, 0.320, 0.273, 0.233, 0.197, 0.163, 0.131, 0.106, 0.087, 0.071, 0.051, 0.035,
 0.020, 0.011, 0.003, 0, 0.001, 0.002, 0.003, 0.004, 0.004, 0.004, 0.004, 0.003, 0.002,
 0.003, 0.003, 0.003, 0.003, 0.002, 0.002, 0.002, 0.002, 0.001, 0.001, 0.003, 0.003,
 0.003, 0.002, 0.003, 0.003, 0.003, 0.002, 0.002, 0.002, 0.001, 0.001, 0.002, 0.001,
 0, 0.001, 0.001, 0.001, 0.001, 0.002, 0.002, 0.003, 0.002, 0.002, 0.002, 0, 0.002,
 0.002, 0.001, 0.001, 0.001, 0.001, 0.002, 0.004, 0.003, 0.002, 0.002, 0.004, 0.004,
 0.003, 0.002, 0.001, 0.002, 0.002, 0.003, 0.003, 0.003, 0.003, 0.003, 0.003, 0.003,
 0.003, 0.003, 0.003, 0.003, 0.002, 0.002, 0.003, 0.001, 0.002, 0.003, 0.001, 0.002,
 0.003, 0.002, 0.001, 0.001, 0.002, 0.001, 0.001, 0.001, 0.001, 0, 0.003, 0.002, 0.001,
 0.002, 0.002, 0.002, 0, 0.001, 0, 0.001, 0, 0, 0.001, 0, 0, 0, 0.001, 0, 0, 0.001,
 0.001, 0, 0, 0, 0, 0, 0, 0.001, 0.001, 0.001, 0, 0.001, 0.001, 0.001, 0.001, 0.001,
 0.001, 0.002, 0.002, 0.002, 0.002, 0.003, 0.002, 0.003, 0.004, 0.006, 0.008, 0.010,
 0.015, 0.020, 0.025, 0.032, 0.040, 0.049, 0.060, 0.072, 0.085, 0.099, 0.114, 0.131,
 0.149, 0.167, 0.186, 0.206, 0.228, 0.249, 0.272, 0.295, 0.317, 0.340, 0.364, 0.388,
 0.411, 0.434, 0.456, 0.479, 0.503, 0.527, 0.549, 0.571, 0.593,

0.996, 0.995, 0.994, 0.993, 0.993, 0.991, 0.990, 0.990, 0.989, 0.988, 0.987, 0.984,
 0.982, 0.979, 0.977, 0.973, 0.969, 0.966, 0.960, 0.955, 0.950, 0.946, 0.939, 0.930,
 0.917, 0.900, 0.881, 0.859, 0.838, 0.816, 0.795, 0.777, 0.760, 0.741, 0.715, 0.686,
 0.654, 0.615, 0.574, 0.539, 0.510, 0.486, 0.458, 0.421, 0.395, 0.383, 0.378, 0.363,
 0.331, 0.286, 0.241, 0.202, 0.176, 0.153, 0.140, 0.130, 0.123, 0.109, 0.094, 0.076,
 0.065, 0.058, 0.053, 0.050, 0.047, 0.043, 0.037, 0.029, 0.024, 0.021, 0.019, 0.019,
 0.017, 0.017, 0.015, 0.014, 0.014, 0.013, 0.012, 0.015, 0.017, 0.020, 0.026, 0.031,
 0.029, 0.021, 0.013, 0.009, 0.005, 0.003, 0.003, 0.002, 0.002, 0.001, 0.001, 0.001,
 0.000, 0.000, 0.001, 0.001, 0.001, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0.001, 0.001, 0.001, 0.001, 0.002, 0.002, 0.002, 0.002, 0.002, 0.002, 0.002, 0.002,
 0.003, 0.002, 0.002, 0.003, 0.003, 0.003, 0.002, 0.003, 0.003, 0.003, 0.003, 0.003,
 0.003, 0.003, 0.004, 0.004, 0.005, 0.003, 0.004, 0.004, 0.005, 0.005, 0.005, 0.005,
 0.005, 0.006, 0.004, 0.005, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006,
 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006, 0.006,
 0.006, 0.006, 0.006, 0.005, 0.005, 0.004, 0, 0.010, 0.033, 0.075, 0.138, 0.219,
 0.308, 0.398, 0.480, 0.551, 0.609, 0.651, 0.682, 0.707, 0.727, 0.744, 0.760, 0.775,
 0.790, 0.803, 0.815, 0.825, 0.835, 0.845, 0.854, 0.863, 0.871, 0.878, 0.885, 0.892,
 0.889, 0.905, 0.911, 0.916, 0.921, 0.925, 0.930, 0.934, 0.939, 0.942, 0.946, 0.949,
 0.953

0.999, 0.998, 0.999, 0.999, 0.999, 0.989, 0.997, 0.998, 0.998, 0.998, 0.998, 0.997,
 0.996, 0.995, 0.994, 0.993, 0.991, 0.991, 0.986, 0.985, 0.983, 0.982, 0.979, 0.977,
 0.972, 0.967, 0.961, 0.952, 0.945, 0.936, 0.927, 0.919, 0.910, 0.901, 0.889, 0.871,
 0.863, 0.849, 0.834, 0.820, 0.808, 0.795, 0.778, 0.757, 0.741, 0.733, 0.733, 0.721,
 0.700, 0.665, 0.633, 0.605, 0.585, 0.565, 0.549, 0.536, 0.531, 0.528, 0.515, 0.493,
 0.481, 0.464, 0.446, 0.424, 0.407, 0.395, 0.388, 0.379, 0.374, 0.368, 0.353, 0.341,
 0.325, 0.322, 0.312, 0.309, 0.309, 0.306, 0.298, 0.296, 0.297, 0.320, 0.353, 0.369,
 0.346, 0.297, 0.253, 0.218, 0.194, 0.176, 0.168, 0.152, 0.128, 0.104, 0.091, 0.086,
 0.081, 0.078, 0.074, 0.065, 0.051, 0.038, 0.034, 0.036, 0.039, 0.035, 0.026, 0.019,
 0.014, 0.011, 0.009, 0.008, 0.007, 0.007, 0.007, 0.006, 0.006, 0.005, 0.004, 0.004,
 0.004, 0.005, 0.004, 0.004, 0.004, 0.004, 0.004, 0.004, 0.003, 0.004, 0.003, 0.004,
 0.003, 0.004, 0.003, 0.004, 0.004, 0.003, 0.003, 0.003, 0.003, 0.002, 0.002, 0.002,
 0.001, 0.002, 0.002, 0.002, 0.001, 0.001, 0.001, 0.001, 0.001, 0, 0.001, 0.001, 0.001,
 0.001, 0.001, 0, 0, 0, 0, 0.001, 0.001, 0, 0, 0, 0.001, 0.001, 0.001, 0.001, 0.001,
 0.001, 0, 0, 0, 0.002, 0.008, 0.021, 0.048, 0.091, 0.155, 0.236, 0.331, 0.435, 0.536,
 0.630, 0.714, 0.784, 0.821, 0.869, 0.906, 0.932, 0.950, 0.962, 0.968, 0.973, 0.975,
 0.977, 0.978, 0.979, 0.980, 0.981, 0.983, 0.984, 0.986, 0.987, 0.988, 0.989, 0.990,
 0.992, 0.993, 0.994, 0.995, 0.996, 0.997, 0.997, 0.998, 0.999, 0.999, 0.999, 1, 1, 1,

1.002, 1.002, 1.001, 1.001, 1.002, 1.002, 1.002, 1.002, 1.002, 1.002, 1.001, 1, 1,
1, 1.001, 1.0, 0.998, 0.999, 0.996, 0.997, 0.996, 0.997, 0.995, 0.995, 0.998, 0.992,
0.991, 0.989, 0.988, 0.987, 0.984, 0.982, 0.981, 0.979, 0.978, 0.976, 0.974, 0.971,
0.969, 0.966, 0.964, 0.960, 0.960, 0.957, 0.955, 0.951, 0.949, 0.947, 0.948, 0.937,
0.932, 0.928, 0.926, 0.921, 0.918, 0.914, 0.911, 0.907, 0.908, 0.904, 0.901, 0.897,
0.893, 0.888, 0.886, 0.883, 0.880, 0.877, 0.875, 0.872, 0.868, 0.857, 0.855, 0.858,
0.852, 0.849, 0.848, 0.848, 0.844, 0.840, 0.844, 0.849, 0.857, 0.860, 0.850, 0.881,
0.813, 0.798, 0.789, 0.778, 0.767, 0.755, 0.743, 0.729, 0.715, 0.708, 0.708, 0.703,
0.698, 0.687, 0.675, 0.664, 0.656, 0.653, 0.655, 0.648, 0.620, 0.590, 0.566, 0.544,
0.526, 0.510, 0.499, 0.489, 0.486, 0.477, 0.466, 0.442, 0.416, 0.388, 0.358, 0.325,
0.299, 0.275, 0.262, 0.261, 0.260, 0.248, 0.231, 0.213, 0.199, 0.186, 0.177, 0.171,
0.164, 0.156, 0.145, 0.142, 0.143, 0.147, 0.148, 0.147, 0.145, 0.146, 0.150, 0.165,
0.190, 0.237, 0.282, 0.308, 0.290, 0.251, 0.211, 0.178, 0.155, 0.136, 0.122, 0.112,
0.106, 0.104, 0.104, 0.106, 0.111, 0.117, 0.126, 0.139, 0.156, 0.1, 0.202, 0.230,
0.263, 0.300, 0.344, 0.392, 0.443, 0.497, 0.552, 0.606, 0.659, 0.708, 754, 797, 831,
864, 893, 917, 938, 954, 967, 977, 986, 991, 996, 998, 1.001, 1.002, 1.002, 1.003,
1.003, 1.003, 1.002, 1.002, 1.001, 1.001, 1, 1, 0.999, 0.999, 0.998, 0.998, 0.997,
0.998, 0.998, 0.998, 0.998, 0.998, 0.998, 0.999, 0.998, 0.999, 0.999, 0.999, 0.999,
0.999, 0.999, 0.999,

1.00, 1, 0.983, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1.0, 0.999, 0.999
 0.998, 0.996, 0.992, 0.986, 0.980, 0.976, 0.972, 0.968, 0.966, 0.964, 0.961, 0.957,
 0.955, 0.951, 0.943, 0.941, 0.938, 0.934, 0.929, 0.925, 0.919, 0.915, 0.910, 0.908,
 0.906, 0.907, 0.904, 0.935, 0.888, 0.883, 0.879, 0.874, 0.868, 0.866, 0.862, 0.862,
 0.853, 847, 833, 831, 824, 819, 813, 810, 805, 802, 798, 0.784, 0.772, 0.765, 0.771
 0.767, 0.765, 0.764, 0.762, 0.756, 0.748, 0.747, 0.757, 0.771, 0.778, 0.766, 0.739,
 0.712, 0.689, 0.677, 0.663, 0.650, 0.634, 0.615, 0.594, 0.576, 0.564, 0.557, 0.557,
 0.550, 0.535, 0.517, 0.501, 0.488, 0.486, 0.491, 0.482, 0.453, 0.413, 0.382, 0.355,
 0.334, 0.315, 0.294, 0.298, 0.296, 0.285, 0.271, 0.248, 0.227, 0.202, 0.177, 0.154,
 0.136, 0.118, 0.106, 0.101, 0.098, 0.091, 0.081, 0.072, 0.067, 0.064, 0.059, 0.056,
 0.052, 0.049, 0.047, 0.045, 0.045, 0.046, 0.046, 0.044, 0.043, 0.043, 0.045, 0.051,
 0.062, 0.086, 0.103, 0.121, 0.119, 0.100, 0.074, 0.056, 0.046, 0.039, 0.035, 0.033,
 0.030, 0.029, 0.029, 0.028, 0.029, 0.030, 0.032, 0.034, 0.038, 0.044, 0.053, 0.065,
 0.080, 0.102, 0.129, 0.164, 0.207, 0.257, 0.314, 0.373, 0.446, 0.515, 0.533, 0.648,
 0.707, 0.761, 0.802, 0.843, 0.879, 0.908, 0.937, 0.951, 0.965, 0.976, 0.984, 0.989,
 0.992, 0.994, 0.995, 0.996, 0.996, 0.996, 0.996, 0.996, 0.996, 0.996, 0.996, 0.996,
 0.996, 0.996, 0.995, 0.995, 0.995, 0.995, 0.996, 0.996, 0.996, 0.996, 0.996, 0.996,
 0.995, 0.995, 0.995, 0.995, 0.995, 0.995, 0.995, 0.995,

0.997, 0.999, 0.999, 0.997, 0.998, 0.993, 0.994, 0.999, 0.997, 0.996, 0.998, 0.998,
 0.997, 0.999, 0.999, 0.998, 0.996, 0.994, 0.994, 0.998, 0.995, 0.994, 0.996, 0.995,
 0.992, 987, 980, 977, 970, 966, 963, 959, 958, 951, 946, 942, 935, 929, 928, 918, 913,
 901, 894, 884, 875, 872, 871, 870, 860, 841, 826, 810, 800, 787, 782, 770, 765, 760,
 756, 742, 0.734, 720, 710, 694, 680, 667, 663, 656, 653, 648, 627, 608, 598, 601, 59
 593, 595, 595, 586, 577, 575, 590, 611, 624, 608, 568, 536, 508, 478, 457, 0.444, 42
 399, 368, 350, 337, 327, 323, 316, 301, 277, 254, 237, 237, 240, 236, 205, 168, 142,
 122, 109, 0.095, 0.086, 0.080, 0.079, 0.079, 0.062, 0.049, 0.037, 0.027, 0.020, 0.015,
 0.011, 0.007, 0.008, 0.001, 0.001, 0, 0, 0.001, 0.001, 0.002, 0.001, 0.001, 0.003, 0.003,
 0.003, 0.002, 0.002, 0.002, 0, 0.001, 0.002, 0.001, 0, 0, 0, 0.001, 0, 0.002, 0.005,
 0.007, 0.006, 0.002, 0.001, 0.001, 0.001, 0.001, 0, 0, 0.001, 0.001, 0.001, 0, 0.001,
 0.002, 0.001, 0, 0.001, 0.003, 0.002, 0.002, 0.003, 0.006, 0.012, 0.023, 0.039, 0.060,
 0.105, 0.157, 0.223, 0.297, 381, 471, 556, 634, 706, 770, 817, 865, 903, 934, 956,
 974, 985, 992, 997, 1.0, 1.002, 1.004, 1.005, 1.005, 1.005, 1.005, 1.005, 1.004,
 1.004, 1.004, 1.003, 1.003, 1.002, 1.002, 1.002, 1.002, 1.001, 1.0, 1.0, 0.998, 0.998,
 0.995, 0.996, 0.994, 0.995, 0.995, 0.995, 0.997, 0.997

0.990, 990, 992, 986, 984, 984, 982, 983, 983, 980, 978, 975, 974, 970, 970, 967,
 963, 959, 954, 953, 951, 948, 946, 942, 934, 925, 912, 899, 885, 875, 0.863, 850,
 840, 830, 822, 810, 794, 770, 747, 729, 717, 702, 682, 654, 633, 625, 629, 623, 602,
 562, 529, 493, 466, 440, 427, 410, 405, 396, 384, 356, 0.343, 330, 317, 298, 280,
 269, 261, 245, 234, 227, 213, 200, 191, 191, 186, 184, 0.186, 184, 179, 178, 177,
 190, 212, 228, 216, 182, 143, 122, 0.100, 0.085, 0.081, 0.074, 0.059, 0.042, 0.034,
 0.031, 0.029, 0.028, 0.024, 0.021, 0.015, 0.011, 0.010, 0.010, 0.009, 0.005, 0.008,
 0.005, 0.004, 0.003, 0.004, 0.003, 0.003, 0.004, 0.004, 0.004, 0.002, 0.003, 0.002,
 0, 0, 0, 0.001, 0.001, 0.002, 0.002, 0.002, 0.002, 0.002, 0.002, 0.003, 0.001, 0.001,
 0.001, 0.001, 0.001, 0, 0, 0.00, 0.00, 0.001, 0, 0.002, 0.001, 0, 0, 0.001, 0, 0.001,
 0.002, 0.001, 0.001, 0, 0, 0.001, 0.002, 0.002, 0.001, 0, 0, 0.001, 0.001, 0.001,
 0, 0, 0, 0.001, 0.001, 0.001, 0.001, 0.001, 0.003, 0.002, 0.002, 0.002, 0.001, 0.001,
 0.003, 0.003, 0.006, 0.014, 0.034, 0.073, 0.127, 0.203, 296, 397, 502, 600, 683,
 753, 789, 838, 875, 902, 921, 934, 943, 949, 953, 957, 960, 963, 965, 968, 971, 973,
 975, 977, 978, 0.980, 981, 982, 982, 983, 982, 983, 982, 983, 984, 985, 988,
 990, 998, 0.994,

1, 1, 1, 0.998, 1, 1, 1, 1, 1.0, 1, 1.0, 1, 1, 1, 1, 1.0, 0.995, 0.994, 0.991, 0.99
 0.989, 0.989, 0.988, 0.984, 0.985, 0.983, 0.981, 0.980, 0.979, 0.975, 0.977, 0.975,
 0.972, 0.972, 0.969, 0.966, 0.964, 0.962, 0.960, 0.953, 0.956, 0.953, 0.949, 0.945,
 0.941, 0.938, 0.937, 0.936, 0.932, 0.927, 0.924, 0.920, 0.917, 0.915, 0.917, 0.913,
 0.910, 0.906, 0.904, 0.901, 0.899, 0.894, 0.891, 0.886, 0.880, 0.878, 0.870, 0.870,
 0.863, 0.861, 0.850, 0.841, 0.841, 0.837, 0.833, 0.826, 0.826, 0.821, 0.810, 0.803,
 0.794, 0.795, 0.797, 0.795, 0.782, 0.762, 0.748, 0.735, 0.725, 0.714, 0.700, 0.687,
 0.673, 0.655, 0.642, 0.631, 0.630, 0.630, 0.621, 0.604, 0.589, 0.577, 0.569, 0.569,
 0.567, 0.556, 0.527, 0.500, 0.480, 0.463, 0.442, 0.427, 0.424, 0.432, 0.445, 0.442,
 0.428, 0.402, 0.382, 0.353, 0.333, 0.306, 0.288, 0.265, 0.265, 0.282, 0.295, 0.285,
 0.266, 0.253, 0.235, 0.225, 0.214, 0.218, 0.215, 0.214, 0.202, 0.203, 0.211, 0.217,
 0.226, 0.222, 0.224, 0.220, 0.219, 0.229, 0.251, 0.300, 0.340, 0.355, 0.339, 0.304,
 0.273, 0.243, 0.223, 0.204, 0.183, 0.180, 0.175, 0.173, 0.175, 0.180, 0.184, 0.191,
 0.199, 0.211, 0.223, 0.246, 0.266, 0.289, 0.315, 0.344, 0.380, 0.415, 0.453, 0.494,
 0.535, 0.580, 0.627, 0.671, 0.714, 0.753, 0.789, 0.820, 0.850, 0.877, 0.900, 0.926,
 0.937, 0.951, 0.963, 0.972, 0.980, 0.985, 0.989, 0.992, 0.994, 0.995, 0.996, 0.996,
 0.995, 0.995, 0.995, 0.994, 0.994, 0.995, 0.995, 0.996, 0.997, 0.998, 0.998, 1.0,
 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1.000, 1.00

1, 1, 1, 1.0, 1.0, 1.0, 0.997, 0.996, 0.995, 0.996, 0.992, 0.992, 0.991, 0.988,
 0.984, 0.982, 0.977, 0.975, 0.990, 0.968, 0.961, 0.955, 0.948, 0.940, 0.934, 0.927,
 0.916, 0.905, 0.893, 0.881, 0.873, 0.865, 0.857, 0.848, 0.834, 0.821, 0.800, 0.781,
 0.761, 0.748, 0.737, 0.728, 0.703, 0.679, 0.666, 0.665, 0.671, 0.670, 0.643, 0.611,
 0.583, 0.556, 0.537, 0.518, 0.510, 0.499, 0.503, 0.500, 0.491, 0.474, 0.467, 0.454,
 0.437, 0.410, 0.393, 0.389, 0.373, 0.371, 0.362, 0.367, 0.343, 0.319, 0.305, 0.289,
 0.286, 0.276, 0.277, 0.262, 0.243, 0.234, 0.218, 0.215, 0.214, 0.210, 0.187, 0.153,
 0.137, 0.117, 0.105, 0.107, 0.110, 0.101, 0.076, 0.054, 0.045, 0.040, 0.037, 0.020,
 0.025, 0.013, 0.012, 0.003, 0.007, 0.008, 0.003, 0.005, 0.003, 0.002, 0.001, 0.003,
 0, 0.001, 0.001, 0.002, 0.003, 0, 0, 0, 0, 0, 0.001, 0.001, 0, 0, 0.001, 0.002,
 0.001, 0.001, 0.002, 0.002, 0, 0, 0.001, 0.001, 0.002, 0.001, 0.001, 0.001, 0.002,
 0.001, 0.001, 0.001, 0.001, 0.002, 0.001, 0.001, 0.001, 0.001, 0.001, 0, 0.001,
 0.001, 0.002, 0.002, 0.002, 0.002, 0.002, 0.001, 0, 0.001, 0, 0.001, 0.001, 0.002,
 0.002, 0.001, 0, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0.001, 0, 0, 0,
 0.003, 0.010, 0.023, 0.046, 0.087, 0.142, 0.214, 0.302, 0.399, 0.499, 0.597, 0.687,
 0.761, 0.812, 0.867, 0.911, 0.943, 0.967, 0.981, 0.990, 0.995, 0.998, 0.998, 0.998,
 0.997, 0.997, 0.997, 0.998, 0.993, 0.999, 0.998, 0.999, 0.999, 999, 1.0, 1.0, 1, 1,
 1, 1, 1, 1, 1, 1, 1, 1.0, 1.0, 1.0

0.958, 0.954, 0.947, 0.938, 0.932, 0.924, 0.917, 0.907, 0.899, 0.885, 0.873, 0.858,
 0.841, 0.820, 0.798, 0.778, 0.755, 0.732, 0.706, 0.676, 0.649, 0.618, 0.584, 0.550,
 0.518, 0.486, 0.447, 0.392, 0.346, 0.314, 0.295, 0.275, 0.263, 0.252, 0.238, 0.212,
 0.184, 0.146, 0.110, 0.084, 0.064, 0.051, 0.039, 0.029, 0.024, 0.021, 0.017, 0.014,
 0.010, 0.007, 0.005, 0.003, 0.002, 0.002, 0.001, 0.002, 0.001, 0.001, 0, 0.001,
 0.001, 0.001, 0.002, 0.001, 0.001, 0.001, 0, 0, 0, 0, 0.001, 0, 0.001, 0.001, 0,
 0.001, 0, 0, 0, 0, 0, 0, 0, 0, 0.001, 0, 0, 0.001, 0, 0.001, 0.001, 0, 0, 0, 0, 0,
 0.001, 0.002, 0.001, 0, 0.001, 0.001, 0.001, 0.001, 0.002, 0, 0.001, 0.002, 0.002,
 0.001, 0.002, 0.001, 0.001, 0.001, 0.002, 0.002, 0.003, 0.002, 0.003, 0.002, 0.001,
 0.003, 0.001, 0.002, 0.002, 0.002, 0.002, 0.003, 0.004, 0.004, 0.003, 0.003, 0.003,
 0.003, 0.003, 0.003, 0.004, 0.003, 0.002, 0.003, 0.003, 0.004, 0.004, 0.004, 0.004,
 0.003, 0.003, 0.003, 0.004, 0.004, 0.004, 0.004, 0.003, 0.004, 0.004, 0.004, 0.004,
 0.004, 0.004, 0.004, 0.007, 0.005, 0.005, 0.004, 0.005, 0.004, 0.004, 0.005, 0.004,
 0.003, 0.005, 0.004, 0.004, 0.005, 0.004, 0.005, 0.005, 0.005, 0.005, 0.004, 0.005,
 0.005, 0.004, 0.005, 0.005, 0.004, 0.004, 0.006, 0.004, 0.001, 0.012, 0.026, 0.072,
 0.122, 0.177, 0.230, 0.273, 0.310, 0.343, 0.373, 0.401, 0.430, 0.458, 0.483, 0.508,
 0.532, 0.555, 0.577, 0.597, 0.618, 0.635, 0.653, 0.672, 0.687, 0.705, 0.722, 0.737,
 0.751, 0.764, 0.777, 0.788, 0.799, 0.812, 0.823, 0.834, 0.845

1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.999	0.997	0.995
0.992	0.989	0.983	0.982	0.980	0.977	0.975	0.972	0.968	0.963	0.958	0.954
0.949	0.945	0.942	0.937	0.935	0.931	0.923	0.917	0.915	0.909	0.910	0.908
0.902	0.892	0.885	0.880	0.877	0.870	0.865	0.857	0.856	0.853	0.851	0.843
0.838	0.831	0.829	0.819	0.810	0.802	0.793	0.789	0.780	0.779	0.757	0.745
0.742	0.741	0.741	0.730	0.735	0.729	0.716	0.704	0.693	0.693	0.695	0.697
0.679	0.651	0.629	0.611	0.598	0.586	0.573	0.553	0.528	0.502	0.483	0.471
0.470	0.468	0.458	0.434	0.411	0.397	0.384	0.384	0.385	0.368	0.329	0.295
0.273	0.256	0.237	0.221	0.221	0.229	0.242	0.239	0.224	0.197	0.176	0.154
0.141	0.119	0.109	0.092	0.088	0.091	0.096	0.087	0.076	0.070	0.066	0.062
0.055	0.055	0.052	0.054	0.050	0.050	0.050	0.054	0.057	0.052	0.049	0.047
0.050	0.037	0.070	0.095	0.121	0.134	0.127	0.106	0.083	0.064	0.054	0.044
0.035	0.029	0.026	0.026	0.025	0.026	0.029	0.030	0.033	0.038	0.045	0.054
0.064	0.076	0.093	0.114	0.140	0.173	0.210	0.251	0.298	0.351	0.407	0.465
0.526	0.586	0.643	0.700	0.751	0.797	0.835	0.871	0.900	0.924	0.944	0.960
0.972	0.981	0.987	0.992	0.995	0.997	0.998	0.999	0.999	0.999	0.998	0.998
0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.997	0.997	0.997	0.996	0.996
0.995	0.997	0.996	0.997	0.998	0.998	0.999	0.999	1.0	0.999		

1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1.0, 0.999, 0.996, 0.992, 0.991, 0.988, 0.985, 0.982,
 0.980, 0.977, 0.974, 0.972, 0.968, 0.961, 0.955, 0.949, 0.943, 0.938, 0.924, 0.917,
 0.910, 0.903, 0.898, 0.891, 0.883, 0.872, 0.863, 0.850, 0.836, 0.822, 0.813, 0.803,
 0.800, 0.783, 0.764, 0.755, 0.750, 0.756, 0.755, 0.738, 0.709, 0.691, 0.671, 0.658,
 0.644, 0.634, 0.620, 0.621, 0.616, 0.609, 0.592, 0.584, 0.576, 0.566, 0.542, 0.526,
 0.519, 0.502, 0.499, 0.492, 0.496, 0.466, 0.438, 0.427, 0.422, 0.420, 0.409, 0.415,
 0.401, 0.382, 0.363, 0.352, 0.350, 0.348, 0.344, 0.321, 0.287, 0.259, 0.237, 0.220,
 0.216, 0.216, 0.203, 0.171, 0.139, 0.125, 0.119, 0.115, 0.107, 0.096, 0.082, 0.064,
 0.050, 0.047, 0.049, 0.050, 0.043, 0.030, 0.019, 0.014, 0.011, 0.010, 0.007, 0.006,
 0.007, 0.003, 0.007, 0.004, 0.003, 0.003, 0.001, 0.001, 0, 0, 0, 0, 0, 0, 0, 0, 0.001,
 0, 0, 0.001, 0, 0.001, 0, 0, 0, 0, 0, 0, 0, 0.001, 0, 0, 0.001, 0, 0.001, 0, 0, 0.001,
 0.001, 0.002, 0.001, 0.001, 0.002, 0.001, 0.002, 0.001, 0.001, 0.001, 0.001, 0.001,
 0.001, 0.001, 0.001, 0.001, 0, 0, 0, 0, 0.001, 0.001, 0.002, 0.002, 0.005, 0.009,
 0.019, 0.035, 0.061, 0.098, 0.151, 0.215, 0.293, 0.380, 0.468, 0.557, 0.644, 0.719,
 0.784, 0.823, 0.872, 0.909, 0.940, 0.961, 0.976, 0.986, 0.993, 0.995, 0.998, 0.998,
 0.998, 0.997, 0.997, 0.996, 0.996, 0.997, 0.998, 0.999, 0.999, 0.999, 0.999,
 0.998, 0.998, 0.998, 0.999, 0.999, 0.999, 1.0, 1, 1, 1, 1, 1, 1.0

0.959, 0.956, 0.950, 0.948, 0.935, 0.927, 0.922, 0.913, 0.905, 0.894, 0.884, 0.869,
0.854, 0.839, 0.817, 0.798, 0.781, 0.766, 0.745, 0.728, 0.706, 0.684, 0.658, 0.629,
0.602, 0.579, 0.546, 0.494, 0.445, 0.420, 0.404, 0.389, 0.381, 0.377, 0.360, 0.341
0.307, 0.258, 0.205, 0.167, 0.142, 0.129, 0.112, 0.095, 0.088, 0.080, 0.080, 0.07
0.064, 0.050, 0.034, 0.022, 0.015, 0.010, 0.008, 0.006, 0.006, 0.004, 0.001, 0,
0.001, 0.002, 0.002, 0.002, 0.002, 0.004, 0.004, 0.004, 0.004, 0.004, 0.003, 0.004
0.003, 0.003, 0.004, 0.004, 0.003, 0.003, 0.005, 0.004, 0.003, 0.005, 0.004, 0.005,
0.003, 0.004, 0.005, 0.005, 0.005, 0.005, 0.002, 0.004, 0.004, 0.004, 0.003, 0.003,
0.004, 0.004, 0.004, 0.005, 0.005, 0.006, 0.003, 0.004, 0.004, 0.004, 0.005, 0.004,
0.004, 0.004, 0.004, 0.004, 0.005, 0.005, 0.004, 0.004, 0.005, 0.005, 0.006, 0.005,
0.004, 0.004, 0.005, 0.004, 0.004, 0.005, 0.005, 0.005, 0.005, 0.006, 0.006, 0.005, 0.005,
0.005, 0.006, 0.007, 0.006, 0.006, 0.005, 0.005, 0.006, 0.005, 0.006, 0.005, 0.006,
0.005, 0.005, 0.006, 0.005, 0.004, 0.005, 0.006, 0.006, 0.005, 0.005, 0.005, 0.006,
0.006, 0.006, 0.006, 0.005, 0.005, 0.005, 0.005, 0.005, 0.005, 0.005, 0.006, 0.005,
0.004, 0.004, 0.005, 0.004, 0.004, 0.005, 0.004, 0.005, 0.005, 0.004, 0.003, 0.00
0.004, 0.003, 0.003, 0.004, 0.003, 0.002, 0.001, 0.003, 0.014, 0.041, 0.089, 0.160,
0.243, 0.330, 0.413, 0.487, 0.544, 0.588, 0.618, 0.644, 0.665, 0.684, 0.700, 0.718,
0.734, 0.750, 0.767, 0.782, 0.798, 0.808, 0.820, 0.830, 0.840, 0.850, 0.858, 0.867,
0.874, 0.882, 0.889, 0.897, 0.903, 0.910, 0.915, 0.922, 0.927, 0.933

0.986, 0.982, 0.983, 0.984, 0.983, 0.981, 0.977, 0.979, 0.972, 0.970, 0.967, 0.967,
 0.963, 0.963, 0.963, 0.955, 0.951, 0.946, 0.943, 0.945, 0.944, 0.939, 0.940, 0.934,
 0.930, 0.930, 0.922, 0.914, 0.916, 0.905, 0.902, 0.899, 0.891, 0.889, 0.886, 0.880,
 0.871, 0.868, 0.856, 0.858, 0.846, 0.841, 0.830, 0.816, 0.814, 0.811, 0.815, 0.812,
 0.802, 0.784, 0.773, 0.760, 0.752, 0.739, 0.732, 0.720, 0.719, 0.712, 0.705, 0.691,
 0.682, 0.676, 0.665, 0.653, 0.641, 0.634, 0.610, 0.616, 0.609, 0.603, 0.593, 0.560,
 0.556, 0.555, 0.553, 0.544, 0.549, 0.539, 0.524, 0.510, 0.496, 0.494, 0.495, 0.491,
 0.464, 0.435, 0.409, 0.390, 0.370, 0.364, 0.356, 0.339, 0.306, 0.273, 0.253, 0.247,
 0.248, 0.236, 0.223, 0.206, 0.193, 0.163, 0.154, 0.152, 0.162, 0.143, 0.116, 0.108,
 0.073, 0.071, 0.063, 0.055, 0.055, 0.057, 0.032, 0.032, 0.072, 0.042, 0.031, 0.022,
 0.031, 0.013, 0.015, 0.013, 0.002, 0.010, 0.011, 0.003, 0.005, 0.003, 0.004, 0.006,
 0.005, 0.003, 0.002, 0.003, 0.003, 0.001, 0.001, 0.002, 0.002, 0.003, 0.002, 0,
 0.001, 0.001, 0.003, 0.006, 0.003, 0.010, 0.011, 0.009, 0.006, 0.002, 0.001, 0,
 0.001, 0, 0, 0, 0.001, 0.002, 0, 0.002, 0.003, 0.002, 0, 0.001, 0.001, 0.002, 0.004,
 0.007, 0.010, 0.017, 0.023, 0.044, 0.070, 0.101, 0.141, 0.193, 0.252, 0.324, 0.403,
 0.475, 0.550, 0.624, 0.692, 0.742, 0.796, 0.840, 0.879, 0.909, 0.934, 0.950, 0.961,
 0.972, 0.973, 0.981, 0.985, 0.981, 0.987, 0.986, 0.983, 0.986, 0.983, 0.986, 0.983,
 0.986, 0.982, 0.986, 0.983, 0.987, 0.989, 0.983, 0.989, 0.983, 0.991, 0.989, 0.990,
 0.983, 0.990, 0.989, 0.991, 0.991, 0.993, 0.997

ORIGINAL PAGE IS
 OF POOR QUALITY